AMERICAN PATHOLOGY IN THE 19th CENTURY: NOTES FOR THE DEFINITION OF A SPECIALTY

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IF we survey the discipline of pathology in the United States in 1976, we can see that it is arranged as a well-organized professional guild that includes about 7,000 board-certified pathologists. We take it for granted that pathology is a pivotal course in the medical curriculum and that hospital laboratories are supervised by well-qualified pathologists. Yet 100 years ago there were fewer than 50 pathologists in the United States. All were connected with medical faculties and hospitals in large cities. One hundred fifty years ago no American physician called himself a pathologist, and the first American text which can claim to be called a treatise on pathology remained to be written.

This essay will trace the development of pathology in the United States during the 19th century, with emphasis on its intellectual roots and on the climate of ideas under which it became separated from clinical medicine and recognized as a distinct discipline. Inevitably, the delineation of such a development requires attention to chronology; the annals—i.e., names, dates, and landmarks—are provided in the accompanying table. Time and place and the reporter's "who, what, when, and where," however, are less important than the evolution of ideas and the development of roles required to fit the needs of a profession which was increasing in numbers and scope as well as improving in quality along with the society it served.

The 19th century inherited only a meager legacy of pathologic thought from American sources. In retrospect we can see that the strength of 18th century European medicine lay in sound clinical observation which afforded a way of distinguishing between diseases and gave some information about their natural history. The weakness of

18th century European medicine lay in its reliance upon systems such as the iatrochemical ideas of Hermann Boerhaave and the neurovitalism of William Cullen. Among the last feeble twitches of the Baconian dragon's tail there were attempts to develop theories based on a priori principles and deductive reasoning. By the beginning of the 19th century it was apparent that such systems were unsatisfactory, probably because, as Robb-Smith put it:[1]

> . . . they had no idea of how the tissues of the body were composed, for their microscopes could not resolve the cells that lay between the fibres and the blood vessels, and so they had to imagine that these fibres and capillaries consisted of globules of lymph or other substances which were built up from chemical elements and that disease arose from some disturbances of this process.

In short, 18th century medicine attempted to develop a theory of disease as an abstract philosophical entity rather than to explain diseases, and the speculations of 18th century theoreticians outran their data.

By the beginning of the 19th century even intelligent laymen recognized that the search for a unifying principle was not fruitful and that theories and systems were not explanatory. Constructing the image of "the adventurous physician," Thomas Jefferson wrote:[2]

> He establishes for his guide some fanciful theory . . . of mechanical powers, of chemical energy, of stimuli, of irritability . . . which lets him into all of nature's secrets at short hand. On the principle which he thus assumes, he forms his table of nosology . . . and extends his curative treatment . . . I have lived myself to see the desciples of Hoffman, Boerhaave, Stahl, Cullen, and Brown succeed one another like the shifting figures of a magic lantern. . . . The patient, treated on the fashionable theory, sometimes gets well in spite of the medicine.

When the unifying principle appeared in the 1850s, it came in part from an unexpected quarter and resulted in a quiet revolution.

Perhaps the clearest example of the effects of the unresolved paradox, the discrepancy between theory and practice, was the case of Benjamin Rush (1745-1813). Along with John Morgan and William Shippen, the other leaders of the Philadelphia school, Rush studied in Edinburgh, where he learned anatomy from Monro (Secundus) and theory

of physic from Cullen. Although Morgan had visited Morgagni in 1764 and the Paduan sage had presented him with a copy of *De Sedibus et Causis Morborum*, it was Rush who was charged with instructing students in the institutes of medicine, a subject which encompassed physiology, pathology, and therapeutics. As time went on, Rush excogitated his own system, an eclectic mixture of ideas taken from Cullen and his epigone Brown, which he grafted onto the framework of Boerhaave's method of teaching. Although Rush's lectures alluded to such illustrious predecessors as Théophile Bonet and Morgagni as well as to his contemporary Matthew Baillie, he did not keep abreast of the new ideas being developed in France by Jean-Nicolas Corvisart and M.-F.-X. Bichat and in Italy by Antonio Scarpa. Samuel Jackson's memoir[3] comments slyly "that the great Rush, after having reduced all the diseases on earth into a unit, should have described every distinct disease most accurately and minutely in his lectures on Practice, is one of the most inscrutable mysteries in the absurdities of learning."

In actual practice, morbid anatomy was not usually pursued with diligence in 18th century America. To be sure, in 1730 Thomas Cadwalader, a pupil of William Cheselden, began giving anatomic demonstrations in Philadelphia, and in a lecture presented at the Pennsylvania Hospital in 1766 he urged upon physicians and students[4] "an industrious pursuit after the hidden causes of all the affections of the human body" through the insights afforded by postmortem examination. But neither Morgan nor Rush emphasized prosection, and Shippen and Caspar Wistar were primarily clinicians. The status of pathology was no better in New York. When Samuel Bard and his colleagues founded the medical school of Kings College in 1767, Peter Middleton was given the professorship of physiology and pathology, the first chair in the United States to include pathology in its title. But the leading anatomist at that school was Samuel Clossy, whose *Observations on Some Diseases of the Parts of the Human Body, Chiefly from the Dissection of Morbid Bodies* had been published in London in 1763. External events compelled Clossy to return to London in 1776 and his brief tenure did little to establish a continuing tradition of exercises in morbid anatomy. Nor was the situation more productive in Cambridge, Mass. When John Warren, Benjamin Waterhouse, and Aaron Dexter formed the ephemeral Harvard Medical School in 1782 (it granted but one M.D. degree), Warren was the anatomist, a man distinguished

for his skill at dissection. He had a cabinet of anatomical and a few pathological specimens at his home and he used them in conjunction with his lectures. But beyond these elementary steps there was no movement of ideas in 18th century American pathology. Whatever pathology was taught to medical students was derivative but not innovative. The occasional autopsy was an act of curiosity or of medicolegal necessity.

The War of Independence, the French Revolution, and the Napoleonic Wars that followed reduced sharply the number of bright young Americans who would have gone abroad for medical training beyond the rudiments available at home. As a result, European ideas took root more slowly than might have been the case had international peace and amity prevailed. The minds and energies of American teachers were occupied with the realities of training doctors in a nation which had barely attained puberty and in which amenities were scarce. The classics of clinicopathological correlation—Morgagni's *De Sedibus. . . .* (1761), Joseph Lieutaud's *Historia Anatomico-medica* (1767), and Matthew Baillie's *The Morbid Anatomy of Some of the Most Important Parts of the Human Body* (1793)—were all part of the standard reading for those assigned to prepare lectures for students, but medical books were expensive and difficult to import. The fundamental idea—i.e., that by examining the gross configuration of organs at autopsy and correlating the same with the symptoms and clinical course one could learn something of the nature of disease—was transmitted more by word of mouth than by example. Like most teaching, it often fell on unreceptive ears. Despite the new nation's intellectual and political affinity with France and the ideas of the encyclopedists, the fact that Lieutaud's text was in Latin made it inaccessible to all but the most scholarly. To be sure, Benjamin Alexander's translation of Morgagni had been printed in London in 1769, but it was a scarce book in the colonies; its first American printing did not take place until 1824. Baillie's monograph was somewhat weaker on clinical correlation than its predecessors and was published a generation later. It is safe to infer that its influence was not felt until after the turn of the century.

Perhaps medicine is somewhat slower to react to philosophical ideas than scientific disciplines which are "pure" as distinguished from "applied," but it took more than a century for the empirical epistemology of Bishop Berkeley and John Locke (both of whom dabbled at medi-

cal practice) and the reinforcement of Humean skepticism to serve as the basis for inductive reasoning and the formulation of generalizations from serial and comparative observations in medical thought. Once the a priori systems were dispensed with, physicians began to think in terms of cause and effect. The first place they looked for the effects of disease—not for disease—was in the body after death. Gradually the autopsy became a useful, then an important, exercise in learning and teaching. As the 19th century unfolded, its primacy became undisputed.

Morgagni's concept of clinicopathological correlation by postmortem examination entered American medicine as an implicit tradition. More fanfare and controversy attended the introduction of the new ideas in medicine promulgated by Corvisart, Bichat, and François-Joseph Victor Broussais, of the school of Paris. As by-products of the French Revolution's libertarianism and spirit of free inquiry, French ideas found a receptive audience in the United States.

Although sometimes credited as such, John Godman's *Contributions to Physiological and Pathological Anatomy* (1825) is not a textbook of pathology. It is a collection of papers on assorted topics, most of them dealing with normal anatomy. Godman was a competent anatomist, but his views on the formation of tumors, for example, betray retrogressive dependence on 18th century theoretical systems:[5]

> Tumors . . . cannot be otherwise considered than as local alterations in the regular structures of the body, consequent to some peculiar impression made on the nerves, and of necessity on the secretory or formative vessels of the part . . . there is a regularity of arrangement in these productions, which appears as if they were *designed* for some important purpose.

But *A Treatise on Pathological Anatomy* (1829) by William E. Horner, professor of anatomy at the University of Pennsylvania, has a legitimate claim to being considered the first reasonably systematic text on pathology published in the United States. Horner extricated himself neatly from the idea of disease as an abstract entity:[6]

> The modern pathologist has ceased to consider *disease* as an independent existence, which may insinuate itself into the human body; and whenever its name is mentioned, he invariably associates with it the existence of a change or lesion in the structure of some part of the body, which in fact, is the disease itself.

True enough, pathologists currently recognize diseases by the lesions

they produce, but we no longer insist that the lesion is the disease itself.

In his introduction Horner pays homage to Broussais, whose theory of inflammation illuminates his text:[6]

> The cellular tissue [connective tissue] is the leading seat of inflammation in most organs, and the activity of the inflammation seems to depend very much on the relative quantity of this tissue. . . . The principles of inflammation [are] uniform both in the acute and chronic stage; with an allowance for difference in texture, one may apply what he [Broussais] has narrated concerning the progress and production of inflammation.

Unfortunately for Horner, the meteoric popularity of Broussais' theories soon receded. The concept of overstimulation (pathological irritation) as the principal cause of disease, and the role of such modifying factors as "ingesta," "miasmata," and "percepta" (psychological influences) was soon found to be as nonexplanatory as the "systems" of the 18th century pundits. Ackerknecht's verdict puts the ideas of Broussais in perspective:[7] "Today, we can see very well where Broussais was right when he fought the ontology of his time and how progressive his physiological concept of disease was. But the main difficulty with the ontology of his time was not that it was ontology but that it was a *false* ontology." Horner played Sancho Panza to Broussais' Don Quixote. They both tilted at wrong, probably illusory, windmills.

But Horner was not merely an exponent of French ideas. A lecture published in 1852 gives us his definition of pathology. To medical students he taught pathology as a descriptive discipline, with emphasis on altered structure and its effect on function:[8]

> The especial object of pathological anatomy is a knowledge of all the derangements of structure and composition to which the human organism is liable; also, a proper appreciation of the influences of these changes upon the ordinary physiological actions of the body of the part affected. As coming, therefore, within its province, we find all the irregularities of position, of continuity, and of contiguity; all departures from ordinary form, texture, color, and proportions; and all the variations in the quantity and quality of fluids. . . . These irregularities are to the physician his means of diagnostic, whereby he distinguishes one disease from another, and upon which he founds his indications of treatment.

The "variations in the quantity and quality of fluids" prefigures the clinical pathology of today; Horner wisely pointed out that diagnosis and treatment, i.e., what it is now fashionable to call the delivery of medical care, are founded on pathology. Such a prophetic definition fortifies the role of the 20th century pathologist as a physician, now more than ever, when so many day-to-day adjustments in the management of patients depend upon results of laboratory determinations.

Horner's anatomically oriented book was soon followed by the clinically oriented text of another Philadelphian, Samuel Jackson, whose *Principles of Medicine, founded on the Structure and Function of the Animal Organism* (1832) was derived from a more durable French influence. Jackson was fortunate in choosing as his model the ideas of Bichat, whose *Anatomie Générale* . . . (1801; first United States printing, 1823) repartitioned organs according to the type of tissue or tissues of which they were composed and posited that vital properties assume a different character in each tissue. Such a theoretical base accounts for symptomatic differences among diseases and supplies a structural scaffolding for considering causality, real or fancied. Jackson's schema was essentially a simplification of Bichat's 21 anatomical elements into 11. His emphasis on clinical phenomena being the result of structural changes was sound. Some of Jackson's perceptions are memorable. He wrote that medicine ". . . is a demonstrative science, and all its processes should proceed from established principles, and be based on positive inductions. That they are not of this character, is to be attributed to the manner of its cultivation, not to the nature of the science itself."[9] And he quoted the comment by T. J. Todd that "medicine never continued long as an art of unbiased observation, and has never yet known the fertilizing influence of the inductive logic." With the penetration of an experienced clinician who had learned the limitation of any given procedure, Jackson stated the limitation of the autopsy, i.e., morbid anatomy unsupported by other disciplines, unilluminated by a clinical context or physiological insight:

> . . . demonstrating to the senses by autopsy the tissues and organs concerned in disease, and the alterations of structure they have suffered, possesses . . . nothing vague or indefinite. As far as it goes, its facts are positive, the knowledge it imparts is certain, yet it is defective. It teaches that which is true, but it is not all the truth. The alterations of structure it reveals are effects; they

have been preceded by an antecedent cause, which is essentially the disease.

Whereas Horner would have his students believe that the lesion was the disease, Jackson wanted his readers to believe that the cause was the disease. Today one would cavil at both and insist that a disease is the total response of the body or of an organ to the cause, and that pathogenic sequence is the key, but insight awaited further elucidation of both structure and function. Jackson's blunt distinction between cause and effect, the search for reality behind appearance, is the hallmark of the inquiring mind without which few important discoveries are made.

But the most important exhibit of American pathology in the second quarter of the 19th century was Samuel D. Gross's *Elements of Pathological Anatomy*.[10] It was widely read and influential, the first edition of 1839 being superseded by a second in 1845 and a third in 1857. Gross was a man of enormous industry; each new edition was extensively revised and amplified by new illustrations.

Although Gross wrote and published the first edition while he was in Cincinnati, he was a Philadelphian by training and he returned to that city as professor of surgery at Jefferson Medical College, where he became the leading surgeon of his era in the United States. Until almost the middle of the century, Philadelphia was stronger in the tradition of morbid anatomy than any other American city. Perhaps its loss of leadership can be attributed to the fact that most pathologists in Philadelphia were not in practice full time, but divided their interests and energies, usually in clinical medicine, occasionally in physiology.

Gross's *Elements* . . . was actually "the first attempt ever made in this country or, indeed, in the English language, to systematize the subject and to place it in a connected form before the profession."[11] For its period it was just what a textbook needed to be. Gross had a gift for synthesizing information from disparate sources; committed only to empiricism and induction, he had no qualms about being eclectic. The American student of pathology profited from the Morgagnian tradition of clinicopathological correlation, the ideas of the school of Paris, and in later editions absorbed the new ideas from Vienna and Berlin, as read through Gross's gleanings. Only slightly less influential was the translation of A. F. Chomel's textbook (1840) as *Elements of General Pathology*, which appeared on the American scene in 1848. There can be little doubt that the influence of the French school, more durably

the ideas of Bichat, dominated American pathology during the second quarter of the 19th century.

An additional thread in the fabric was added in the 1840s, when Carl Rokitansky's *Manual of Pathological Anatomy* made its appearance in English under the imprint of the Sydenham Society (1849), a translation of the German text of 1842 to 1846. Rokitansky's humoral doctrine of crases and stases in body fluids as the unifying principle of disease had but short-lived popularity; however, it was the opening event in a sequence that established the hegemony of German and Austrian supremacy in morbid anatomy, a position of dominance which lasted well into the 20th century.

In 1848 W. E. Horner, then in his mid-50s, embarked on a busman's tour of England and Europe, visiting many major medical centers. Reporting to his students on his return,[12] he presented a vivid first-hand description of some events in the revolution of 1848 which he had witnessed in Paris in May of that year. He commented about Rokitansky's role at the Allgemeine Krankenhaus that "The Professor is neither a prescriber in the hospital, nor is he even a practising physician"—i.e., he had no private clinical practice. In that sense Rokitansky was the first "full-time" pathologist; he earned his living by supervising autopsies and teaching pathology. Up to this era American anatomists and pathologists had all devoted much of their time to clinical practice, because fees earned from lectures and demonstrations were small. Although several medical schools had professorial chairs in which pathology was part of the title, the Harvard Medical School became the first to have a chair devoted exclusively to pathology when it appointed J. B. S. Jackson professor of morbid anatomy in 1847.

Jackson is best remembered for the development of a pathological museum[13] which became the nucleus for Harvard's famous Warren Anatomical Museum. Similar collections had been formed on a smaller scale in other medical schools following the tradition developed in England and Europe. Jackson was probably influenced by the plan of the museum at Guy's Hospital which Thomas Hodgkin had organized in 1825-1832. Much of the teaching of pathology was based on demonstration of museum specimens, and Horner's lecture[12] devotes space to appraisals of the various pathological museums that he visited in London, Paris, and Vienna. Further impetus was given to this aspect of pathology in 1862 when Surgeon General William Hammond ordered

the foundation of the Army Medical Museum at Washington. This was destined to become one of the finest collections of its type, and it was so organized that it provided a nucleus for research. The learned and redoubtable John Shaw Billings served as its curator from 1883 to 1893, using his influence to establish it as a center of learning in pathology.

As the United States marched toward what was heralded as its "manifest destiny" during the first half of the 19th century, many new medical schools were founded; provision was made for teaching pathology in all. But the actual achievements of American pathology in that period were few. Perhaps the best-known contribution was by William Gerhard, who never occupied a chair of pathology. Returning to Philadelphia in 1837 from studies with Pierre Louis at Paris, he was able to distinguish between typhoid fever and typhus by noting in the latter the lack of ulceration of Peyer's patches, the lack of mesenteric lymph-node involvement, and the absence of splenomegaly;[14] but priority for this observation belongs to H. C. Lombard, who had published similar observations independently at Dublin a few months previously. The point of departure for Oliver Wendell Holmes' study on the contagiousness of puerperal fever (1843) was an autopsy on a woman who had died of the disease, but Holmes was not a pathologist and he did not develop his argument along the lines of morbid anatomy. Alonzo Clark was the leading figure in pathology in New York; he published many useful papers, but they dealt more with clinical than pathological problems. Perhaps the most valuable contribution to pathology made by an American before the Civil War was Austin Flint's *Practical Treatise upon the Pathology, Diagnosis and Treatment of Diseases of the Heart* (1857). Flint, whose name is still associated with a specific heart murmur, was chiefly an internist, but he had studied pathology at Harvard Medical School and taught the subject at Buffalo Medical College. His grasp of morbid anatomy was responsible for his skill as a diagnostician, hence the enduring value of his monograph.

During the period before 1850 physicians began to form special societies of pathology. The Philadelphia Pathological Society was founded by William Gerhard in 1839; it survived only four years but was reconstituted in 1857. A pathological society was founded in Washington in 1841. The first such society to maintain continuous existence was the New York Pathological Society, established in 1844.

The papers and discussions presented at meetings were clinically oriented because most of the members were practicing physicians. But the papers derived from anatomical observations. Specimens were displayed and emphasis on clinicopathological correlation ensured the continuation of Morgagni's method. The formation of such societies signalled recognition within the profession that pathology was a discipline which examined disease from a perspective different from that of bedside medicine and which contributed a different form of understanding. From such small groups one can trace the development of the professional guilds of today.

However, the events which were to prove decisive for American pathology, indeed for all biological sciences, were taking place in Germany, France, and England during the 1850s. In the last years of that decade three important ideas were published that created a general shift in biological thinking. In *Die Cellularpathologie* (1858) Rudolf Virchow stated that all cells come from preceding cells (*omnis cellula e cellula*); by disproving spontaneous generation of bacteria, Louis Pasteur (1858) showed that all microorganisms come from preceding microorganisms; Charles Darwin's *Origin of Species* (1859) demonstrated that all species are derived from preexisting species. Using the observations and language of his own discipline, each of these investigators was making the same statement: living substance arises only from living substance; there is continuity of the life process, regardless of our ignorance of its genesis. It was in the reference frame of this *Zeitgeist* that pathology began to develop rapidly. It is surely a controlling feature that the principles enunciated by two of the three scientists, Virchow and Pasteur, found immediate application in the laboratory of pathology, where they helped solve medical problems. By implication, Virchow, Pasteur, and Darwin added the concept of continuity of germ plasm to the notion of epigenesis. This concept was first formulated, imperfectly, by William Harvey in the 17th century. It was revised and improved by Caspar Wolff's germ-layer hypothesis in the next century. It was further refined by Carl Ernst von Baer's *Über Entwicklungsgeschichte der Thiere* (1828-1834) and Robert Remak's final tripartite division of the embryo (1845) into three germ layers: ectoderm, mesoderm, and endoderm. The importance of these discoveries was recognized speedily.

The new ideas of Virchow, Pasteur, and Darwin did not go unchal-

lenged. But opposition to Virchow and Pasteur was apparent chiefly within professional circles and in the scientific press, whereas the acrimonious contest over evolution was waged in the public forum. Thomas Huxley's debate with Samuel Wilberforce is too familiar to require comment—and so is the Scopes trial in Dayton, Tenn., as late as 1924. Martin Green supplies an interesting synoptic view of what happened in Boston in the 1860s:[15]

> Agassiz declared against Darwin, and Boston as a whole followed Agassiz. John Amory Lowell reviewed *The Origin of Species* unfavorably for *The Christian Examiner;* the Lowell Institute refused to have John Fiske lecture on evolution; Ticknor and Fields refused to publish the Scientific Series which included Darwin, Tyndall, Huxley, Buckle, and Lecky. Instead, Appleton published it in New York, and Ferris Greenslet says this was the first step in Boston's losing its primacy in publishing.

By contrast, with minor short-lived exceptions, the doctrines of Virchow and Pasteur were accepted readily in the United States, and laboratory medicine continued to develop without storms.

Toward the end of the century Whitman[16] compared their generalizations to the Law of Conservation of Energy in physics, labelling the concept the Law of Genetic Continuity or the Law of Homogeneity. This is the unifying principle which governed all later developments in pathology. We still continue under this dispensation.

So far we have neglected to take account of the various technological improvements which made possible the observations upon which the theoretical framework was built. Morgagni's studies were based on gross dissection alone. Bichat's ideas about organs and tissues stemmed chiefly from similar dissections supported by the imperfect microscopes of his day. By the 1830s it was possible to construct a lens free from chromatic aberration; objects previously surrounded by a hazy halo were now clearly distinguishable. In 1830 Johannes Evangelista Purkinje built the first crude microtome, which produced thick and uneven sections. The resolving power of lenses was still so poor that Theodor Schwann's famous cell theory of 1839 maintained that cells crystallized from an amorphous fluid matrix. Conceptually, given this limitation, the cell theory was only a slight advance over Johann Christian Reil's idea (1795) that fibers were the structural unit of the body. For this reason the cell theory could easily be fitted into the prevailing humoral

theories of disease, such as Rokitansky's theory of crasis and stasis.

A quick survey of the development of the microscope shows us that water-immersion lenses were first displayed at the Paris exposition of 1855, that Ernst Abbé developed the oil-immersion lens in 1879, and that the Abbé condenser which materially improves illumination and resolution was not developed until 1886. Improvements in methods of preparing tissue for microscopical examination continued. Wilhelm His developed the first satisfactory microtome in 1865. In 1869 Theodor Klebs first used melted paraffin to support an object while it was being sectioned; his next step was to infiltrate the entire object. The first sliding microtome was built by Charles Sedgwick Minot at Boston in 1885. In the following year he constructed the first rotary microtome. Since sections were thick by today's standards—probably from 12 to 20 microns—oil of cedarwood or oil of origanum were needed to clear the sections. Modern improvements having made this step unnecessary, these two agreeable fragrances have disappeared from the laboratory. The idea of staining microscopical preparations was not new, but in 1858 Joseph Gerlach[17] directed attention to the value of carmine as a histological stain; thereafter, explorations of natural stains, especially variations of hematoxylin extracted from logwood, developed rapidly. The next decade saw the beginning of the aniline dye industry, especially in Germany. Synthetic stains now opened a wide vista of Titianesque "microscapes" that revealed the structure of diseased tissues and cells to the histopathologist. In the 1870s stained microscopical sections were first used to teach histology and pathology to students.

Another advance was in photomicrography. Joseph Janvier Woodward, working at the Army Medical Museum, was a pioneer in producing useful photomicrographs of histopathological material,[19] an indispensable technique for communicating the empirical observations from which inferences in morbid anatomy are made. Woodward had studied with Horner in Philadelphia. He developed a microscopical technique so precise that in 1870 he was able to demonstrate the stomata between endothelial cells lining small blood vessels, thereby providing the anatomical basis to support Julius Cohnheim's theory of leukocytic diapedesis as an essential step in the cellular response to inflammatory agents.[18]

The concepts of Virchow and Pasteur reinforced each other. For the first time pathologists could identify a specific cause for a specific disease; it therefore became easier to classify infectious diseases into

distinct entities. Not only was a more precise nosology feasible, but the security of diagnosis rested upon reproducible laboratory determinations. Technical advances in microscopy and in the preparation of tissue for microscopical study were supplemented by comparable improvements in bacteriological methods. No longer could pathology be taught by a part-time lecturer with the aid of a few charts, a blackboard, and some specimens fixed in spirits. The equipment and apparatus required for even the simplest anatomical pathology of the 1870s now required a separate room, i.e., a laboratory, and sometimes even an assistant and a technical staff. At the same time, the requirements of hospitals became more complex and more cohesively organized. Until methods for bacteriological investigation became available, almost the only function of the clinical laboratory was the analysis of urine. Tests for albumin developed by Frederik Dekkers and William C. Wells in the 18th century and applied to kidney disease by Richard Bright and John Bostock in the 1820s, Golding Bird's description of urinary concretions in the 1840s, and Bence Jones's unusual test of the same decade exemplify interesting stages. Such tests were usually carried out by a hospital chemist. The example of Rokitansky had shown the advantages of an autopsy service supervised by an individual who made it his special field of practice. American hospitals gradually recognized the limitation of having postmortem examinations performed by the physician or surgeon who had treated the patient. Shortly after 1850 the Massachusetts General Hospital appointed Calvin Ellis curator of the pathological cabinet and microscopist; his duties included performing the autopsies. The Boston City Hospital created the position of pathologist in 1865, but its early incumbents were primarily clinicians interested in pathology.

The first real laboratory of pathology in America was opened in 1877 at the College of Physicians and Surgeons in New York at the instigation of Francis Delafield, with T. Mitchell Prudden as its director.

Delafield's *Handbook of Post-Mortem Examinations and Morbid Anatomy* (1872) was the first major American textbook on general pathology after Gross's *Elements*. . . . It barely betrays the fact that its author devoted as much of his time to internal medicine and private practice as to morbid anatomy, and it was the forerunner of the famous textbook by Delafield and Prudden (1885), which served many generations of students and physicians so well.

As befitted the intellectual climate and the available techniques, Prudden and other pathologists trained in this first laboratory made important contributions to the study of infectious diseases, notably diphtheria, streptococcal infections, and tuberculosis. The most influential laboratory of pathology founded during this period was that created at the newly organized Johns Hopkins Hospital in 1886 under the leadership of William H. Welch. A medical statesman and the leading public spokesman of pathology for almost half a century, Welch had returned from studies with Cohnheim, Friedrich von Recklinghausen, Wilhelm Waldeyer, and Felix Hoppe-Seyler possessing a strong orientation toward research as a decisive element in postgraduate training. His laboratory at Baltimore was the best equipped of its generation in the United States. As befitted a pathologist of that era, Welch's most memorable contribution was the discovery of the gas gangrene bacillus that bears his name, *Clostridium welchii*.[20, 21] The reputation of his laboratory as a training ground for future professors of pathology and laboratory directors was rivalled only by that of Virchow's Institute in Berlin. A partial list of men trained by Welch includes such names as those of Simon Flexner, William G. MacCallum, Eugene L. Opie, George H. Whipple, Milton C. Winternitz, and Ernest W. Goodpasture—men whose contributions largely shaped academic pathology in the United States during the first third of the 20th century. Welch's commitment to research is not only identifiable in his work and the work of his students, but by his selection as first editor of the *Journal of Experimental Medicine* when it was founded in 1896.

Only misplaced chauvinism would claim that during the last three decades of the 19th century the contributions of American pathology matched those of the older, better established foundations on the European continent. However, a few durable contributions to morbid anatomy were made. One cannot review the era without mentioning J. J. Woodward's observations on the histopathology of yellow fever[22] and on pseudopolyps of the colon in ulcerative colitis,[23] Reginald Fitz's classic study of appendicitis,[24] and the early studies of James Homer Wright on blood cells and platelets.[25] Even though Fitz's observations were made mainly from autopsy material, one can make a case for his investigation as the beginning of surgical pathology in America. Pathologists had examined surgical specimens before 1886; but until surgical anesthesia and asepsis became widely available, surgical specimens were

limited in range. The pathology as well as the surgery of tumors were in their infancy. Fitz's contribution was a major step in elucidating the pathogenesis, morbid anatomy, and treatment of a common and misunderstood disease.

West of the Appalachian Mountains pathology developed more slowly as an academic discipline than in the cities on the east coast. The appointment of Christian Fenger, who had studied with Rokitansky, as pathologist at the Cook County Hospital in 1878 paved the way for sound teaching to be established in Chicago. Among Fenger's leading students were Howard T. Ricketts, whose tragic death is memorialized in the term "Rickettsia"; H. Gideon Wells, whose influence dominated chemical pathology in later years; and Ludwig Hektoen, who was the leading figure in midwestern American pathology for the first half of the 20th century.

Although pathologists had been prominent in the programs of the Association of American Physicians since its inception in 1886, the close liaison between post-Virchovian pathology and post-Pasteurian bacteriology was emphasized in the name chosen in 1901 for the first national guild of pathologists, the American Association of Pathologists and Bacteriologists. For a quarter of a century this society's official organ was the *Journal of Medical Research*, which had begun publication a decade before; in 1925 the *American Journal of Pathology* replaced it. The alliance between pathology and bacteriology was recognized somewhat earlier in England when the *Journal of Pathology and Bacteriology* was started in 1892. The joint title persisted until 1968-1969, when it underwent mitotic division, the new journals being titled the *Journal of Pathology* and the *Journal of Medical Microbiology*, separate and equal.

The term "medical research" must have had avant garde appeal for the founding fathers of 1901 because during the two previous decades American pathologists had laid the foundation for experimental studies in their newly founded laboratories. Quite early, research potential was recognized as the intellectual hallmark of the academic pathologist. Not only had the isolation of bacteria furnished a means of creating animal models of human diseases, but pathologists of that period wanted to test by experimental methods the hypotheses that they had constructed to explain morbid processes revealed by autopsies. In the last two decades of the 19th century American pathology could rightly claim to par-

ticipate in the trivium of service, teaching, and research. The next century saw the fruits.

The 19th century encompassed a steady and sequential change in the role of the pathologist. At the beginning of the century pathology was merely an anatomical handmaiden to clinical medicine. Its only claim to intellectual autonomy was its ability to relate the symptoms and natural history of disease to lesions seen at autopsy. Without sacrificing this essential method of informing medical processes, the discipline absorbed one or another of the theories of the French school, most successfully that of Bichat, who founded his theory of disease upon particular properties of organs and tissues. Along with this new outlook went a limited degree of intellectual differentiation. It was clear to medical faculties that morbid anatomy approached medical entities differently from bedside medicine. As a consequence, teachers of pathology were accorded a titular distinction and a separate place in the curriculum. However, most still had to engage in some form of clinical practice.

When Schwann's cell theory found application to human disease through Virchow's doctrine of cellular continuity, Pasteur concomitantly demonstrated the same principle in bacterial cells, and these two major advances in theory were supported by a developing technology, the stage was set for pathology to establish itself as an independent discipline. Interaction of new theory and new technology with expanding social institutions—medical schools and hospitals—resulted in the formation of laboratories or institutes of pathology directed by physicians with the title of pathologist or its equivalent.

In less than two decades it became feasible for a physician to decide to devote his full professional career to pathology and to foresee what shape that career might take and what his professional commitments would be, i.e., what sort of work he would be doing. By the same token, at the end of the century it was possible for an institution such as a hospital or a medical school to employ a physician designated as pathologist and to have a clear understanding of his duties and responsibilities.

Just after the 20th century began, American pathologists organized their first professional society (or guild) at a national level. From that time to the present pathology has been a distinctive specialty within medicine, often described as laboratory medicine in contrast to bedside

medicine, a field with its own methods and its own particular contribution to make to medical science. It also has acquired its own hierarchy, its own rituals, and even its own jargon. But in both a didactic and a practical sense pathology is uniquely the basic science that connects preclinical and clinical studies. Such disciplines as anatomy, histology, embryology, biochemistry, physiology, and microbiology can be found in the curricula of graduate schools in the biological sciences as well as in medical schools. Pathologists do not hesitate to share the methods of these fields and to incorporate their substance, using this body of knowledge as the essential component upon which medicine in all its branches depends, providing the basis for diagnosis and treatment. Perhaps in a large sense pathologists serve to reconcile the issues of life and death to other physicians.

Selected Events in 19th Century Pathology in the United States

1823: M.-F.-X. Bichat: *Anatomie Générale* . . . first translated into English and published in the United States.

1824: Giovanni Battista Morgagni: *De Sedibus et Causis Morborum* (translated by Benjamin Alexander, London, 1769) first published in the United States.

1829: William E. Horner: *A Treatise on Pathological Anatomy*. First monograph on pathology written in the United States.

1832: Samuel Jackson: *Principles of Medicine, founded on the Structrue and Function of the Animal Organism* published. (Shows the influence of Bichat.)

1837: William W. Gerhard distinguished typhoid fever from typhus on the basis of both clinical and pathological features.

1839: Samuel D. Gross: *Elements of Pathological Anatomy*. First systematic textbook on pathology (2d ed. 1845, 3d ed. 1857).

1844: New York Pathological Society founded. The oldest professional pathological society with continuous activity in the United States.

1847: Alonzo Clark appointed lecturer in physiology and pathology at the College of Physicians and Surgeons, New York (appointed professor in 1848). J. B. S. Jackson appointed professor of pathology at Harvard Medical School; first full-time chair devoted exclusively to pathology in the United States.

1851: Thomas M. Markoe appointed professor of pathology and microcopic anatomiy at the Medical College of the City of New York (New York University).

1853: Francis Donaldson (University of Maryland, Baltimore): *Practical Application of the Microscope in the Diagnosis of Cancer.*

1854: J. B. S. Jackson appointed Shattuck Professor of Pathological Anatomy at Harvard Medical School.

1855: Calvin Ellis appointed microscopist and curator of the Pathological Cabinet at the Massachusetts General Hospital.

1857: Austin Flint: *Practical Treatise upon the Pathology, Diagnosis, and Treatment of Diseases of the Heart.*
Edmund R. Peaslee (Dartmouth): *Human Histology in its Relations to Descriptive Anatomy, Physiology and Pathology.*

1860: Robert Ray, Jr.: *Catalogue of the Pathological Cabinet of the New York Hospital.*

1862: The Army Medical Museum founded. John Shaw Billings, curator 1883-1893, founded the Surgeon General's Library.

1863: Photographic department added to the Army Medical Museum. J. J. Woodward, director.

1865: Boston City Hospital established position of pathologist (part time).

1867: Moses Clark White appointed professor of pathology and microscopy at Yale.

1870-
1888: *Medical and Surgical History of the War of the Rebellion* published, six volumes.

1871: Reginald H. Fitz succeeded Calvin Ellis at the Massachusetts General Hospital.

1872: Francis Delafield: *Handbook of Post-Mortem Examinations and Morbid Anatomy.* (Precursor of Delafield and Prudden's textbook; 1st ed. 1885, 16th ed. 1936)

1877: Pathology laboratory at the College of Physicians and Surgeons, New York founded. T. Mitchell Prudden, director.

1878: Christian Fenger appointed pathologist at Cook County Hospital in Chicago.

1879: Reginald H. Fitz appointed Shattuck Professor at Harvard Medical School.

1881: William H. Welch wrote the section on pathology for Austin Flint's *Principles and Practice of Medicine*, 5th ed.

1882: Christian Fenger appointed Professor of Pathology at Northwestern University.

1886: Pathological Department opened at Johns Hopkins University. William H. Welch, director. Reginald H. Fitz conclusively demonstrated the pathology of perforative inflammation of the vermiform appendix.

1891: Boston City Hospital established the position of full-time pathologist.

1892: William H. Welch identified *Bacillus aerogenes capsulatus (Clostridium welchii)*.

William T. Councilman appointed Shattuck Professor at Harvard Medical School; other members of the department of pathology included Frank B. Mallory at the Boston City Hospital and James Homer Wright at the Massachusetts General Hospital.

Study on amebic dysentery by William T. Councilman and Henry A. Lafleur published.

1895: Theobald K. Smith appointed director of the Massachusetts State Board of Health.

1896: Theobald K. Smith appointed professor of comparative pathology at Harvard Medical School.

1897: Frank R. Mallory and James Homer Wright: *Pathological Technic*.

1901: American Association of Pathologists and Bacteriologists founded under the leadership of William T. Councilman and Harold C. Ernst.

Epilogue

The experience of 19th century pathologists in teaching their subject was codified after the turn of the century. In 1904 the Council on Medical Education of the American Medical Association organized subcommittees to explore standards of teaching in the country's medical schools. William T. Councilman, then Shattuck Professor of Pathological Anatomy at the Harvard Medical School, was the chairman of the subcommittee on pathology and bacteriology. Its report[26] was published in 1909 and recommended that pathology and bacteriology be taught in the second year of a four-year program, that 500 hours be

allotted to both subjects (bacteriology being given one third to one half the time), that prerequisite courses consist of anatomy—including histology and embryology—physiology, and chemistry, that heads of departments work on full-time schedules, that some instructors be on full time while others have part-time clinical interests. Councilman emphasized laboratory teaching:[26] "The didactic, the microscopic, and the naked eye study should go hand in hand together." These principles were adopted widely. With local variations depending upon specific situations, this is the way pathology was taught during the first two thirds of the 20th century.

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